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OPERATING MANUAL

MODEL 1000 HYGROMETER

MP MASTER
MA30184

PANAMETRICS

221 Crescent St. / Waltham, Mass.
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OPERATING PROCEDURE

The Panametrics Hygrometer Model 1000 has been designed and manufactured as a precision laboratory instrument and under normal operating conditions and normal handling will provide a long trouble-free operating life. However, to insure that the instrument has not been damaged in shipment, and does operate properly, the following checkout procedure should be followed:

1. Immediately after unpacking, inspect the instrument to ascertain that no physical damage has occurred during shipment.

2. Inspect each sensor probe accompanying the instrument. Each sensor element is carefully packed in a separate container to protect the sensitive aluminum oxide element from damage. The element container is intended for reuse in protecting the element when the probe is not in use. Each sensor element is shipped with a sensor input cable unless it is ordered separate and without cable.

3. Place the Hygrometer on a bench or table and plug in the line cord into a 115 VOLT 50-60 CYCLE AC OUTLET (UNLESS ORDERED FOR 230 VOLT OPERATION) with "Range Switch" in "OFF" position. Inspect meter to insure that the meter indicator needle is on zero. If it is not, use a small screwdriver to turn the "zero adjust screw" located in the panel below the meter, and adjust to zero reading.

4. Next turn the "Range Switch" to the calibrate position (CAL) and observe meter reading. The meter indicator needle should read full scale. If it does not, adjust the calibration potentiometer located on the rear panel until the meter reads full scale.

5. The Hygrometer is now checked out and ready to place in operation for Dew/Frost Point Temperature measurements in the following manner. Connect the sensor probe cable to one of the five (5) input jacks located on the rear panel. Set the "Select Switch" to the input jack chosen and turn the "Range Switch" from the Calibrate position to the Range 10 position. If the meter reads 1/3 scale or less, turn the "Range Switch" to Range 3 position for greater sensitivity and reading accuracy. Again, if the meter reads 1/3 scale or less, turn the "Range Switch" to Range 1 position for greater sensitivity.

On Range 10, use the upper scale x 10. On Range 3, use the lower scale x 1. On Range 1, use the upper scale x 1.

If more than one input probe is used and the additional probes are used to monitor different locations, then the above procedure should be used to determine the scale to be used with each probe input to insure the greatest reading accuracy.

When the Panametrics Hygrometer Model 1000 is ordered with the nickel-cadmium battery pack the same checkout procedure is used. However, one additional step should be taken during the calibration check. After checking the meter reading at calibrate (CAL) in the AC mode, move "Switch S-3" to the battery position. "Switch S-3" is located on the rear panel. The full scale reading on calibrate should be approximately the same for the battery mode of operation as for the AC mode unless the battery pack is in a discharged state.

Please note that when the "Range Switch" is in the OFF position, both AC and DC supplies are inactivated. Whenever the "Range Switch" is in any position except OFF (with the line cord plugged into a 115 volt AC outlet) the battery pack is on a trickle charge rate that will not damage the battery pack even over prolonged period of charging. In the battery power mode, starting with a fully charged battery pack, the instrument can be operated for 12 to 14 hours continuously before the battery pack is discharged. If at that time "Switch S-3" is changed to the AC mode of operation the battery pack will be automatically recharged.

A calibration chart is attached to the front panel of the instrument and contains calibration data for the number of probes ordered with the Hygrometer. If the unit is ordered with one (1) probe and it is later decided to attach additional probes to the instrument, each new sensor probe ordered will be accompanied by calibration data that can be added to the original calibration chart. A new chart may be supplied containing the calibration data for all the probes ordered for a particular serial numbered instrument.

To either add data to the existing calibration chart or to replace the old chart with a new one it is necessary to remove the two (2) window mounting screws and lift out the plexiglass window. After the additional data is entered or the chart is replaced, the window is re-installed in the same manner. Please note that one (1) additional blank chart is supplied and will be found immediately underneath the original calibration chart supplied with the instrument.

ALUMINUM OXIDE SENSOR

Theory of Operation

The sensor consists of an aluminum strip which is anodized by a special process to provide a porous oxide layer. A very thin coating of gold is evaporated over this structure. The aluminum base and the gold layer form the two electrodes of what is essentially an aluminum oxide capacitor.

Water vapor is rapidly transported through the gold layer and equilibrates on the pore walls in a manner functionally related to the vapor pressure of water in the atmosphere surrounding the sensor.

The number of water molecules absorbed on the oxide structure determines the conductivity of the pore wall. Each value of pore wall resistance provides a distinct value of electrical impedance which in turn is a direct measure of water vapor pressure.

Range

The standard sensor probe will measure water vapor from Dew/Frost Points from +20°C to -110°C. This range represents a change in moisture from 20,000 ppm to about 0.001 ppm, over seven orders of magnitude difference.

The calibration chart attached to the front of the instrument can be used to quickly determine the Dew/Frost Point to within 2.5°C for most of the range. For more accurate readings, the calibration curve supplied with each sensor should be used. The calibration curves and appropriate station positions on the chart are numbered accordingly; above 0°C Dew Point readings are referenced to the vapor pressure over water. Below this value they are referenced to ice.

Operation and Use of Sensor

The sensor is available with either a flange or pipe thread mount (P1 or P2). Readings may be made immediately once the sensor is installed in the receptacle of appropriate dimensions and connected by cable to the Model 1000.

Although Dew Point readings can be made with the sensor to +20°C or higher, it is primarily intended as a device for the measurement of extremely small quantities of water. For this reason the sensor is mounted on a slender bus wire attached to a teflon rod to insure a minimum of water absorbing surfaces in the vicinity of the aluminum oxide surface.

In view of its necessarily fragile nature, care should be exercised in the use and handling of the sensor. The aluminum oxide element and its supporting wires should never be touched directly or allowed to come into physical contact with foreign objects. Such contact may result in the bending of the aluminum strip or a break in the lead wire contacts.

The sensing element may be cleaned by directing a gentle stream of air to its surface. When not in actual use the element may be stored in its original shipping container.

Observing these few simple precautions will result in a long and useful sensor life.

The sensor will measure the water vapor pressure in its immediate vicinity and, thus, the readings will be influenced by its proximity to the system walls, materials of construction, etc. If the observation of rapid system changes are desired the sensor should be exposed to the free gas environment to the maximum extent possible. The sensor can be operated under vacuum or pressure, flowing gas or static conditions.

Performance Characteristics

The sensor will provide an extremely fast response. A 63% change in reading will on the average be achieved within 7 seconds to a step function increase or decrease in water vapor concentration. This speed or response should be more than adequate to follow almost all use conditions since true step function changes in moisture levels are rare. Even with abrupt changes, the level of flow, wall construction materials, etc., tend to modify these conditions because of absorption, desorption and mixing effects.

The sensor may be used at any ambient air temperature from the Dew/Frost Temperature (to a maximum of +20°C) to +60°C. Moisture condensation on the sensor should be avoided as it will cause an error in reading. The sensor may be dried with an air flow if such a condition occurs.

THEORY OF OPERATION

The Hygrometer as designed for use with the Panametrics aluminum oxide sensor is a complex impedance meter which measures the variable displacement and in-phase currents of the sensor under the humidity conditions to which it is exposed. The sensor impedance is a complex one which may be approximated by a resistor and capacitor parallel combination whose magnitude of impedance value ranges from 10K to 2 megohms with a "phase angle" range of 30°-60°. The design of the meter for measuring the sensor's impedance consists of the following, as shown in the block diagram, Figure 1:

1. A precise 154 cycle oscillator.
2. A divide-by-two binary stage.
3. A precise 1 volt square wave source.
4. An AC coupled operational amplifier with precision attenuator.
5. A synchronous demodulator.
6. A meter circuit.
7. Necessary regulated power supplies.

The meter operates from either 115 V or 230 V AC, 47-63 cycles single phase power, or from rechargeable nickel cadmium batteries. The selection of rear panel power switch selects either the AC power or the external battery sources. While the meter is operating in the AC mode, the nickel cadmium batteries are on constant trickle charge at a safe rate within the rating of the batteries. The AC power supply converts the line voltage through half wave rectifiers, filters, and regulators to $\pm$ 15 V. For use on the high range where the sensor requires a heating element, power is obtained from the negative 15 V unregulated supply. This voltage is approximately 25 V DC. To provide the precision voltages for the oscillator and the square wave amplifier, an additional regulator is used to provide an accurate 9 V source. Also, the +15 V is stepped down to +5 V to power the Binary Stage. While the meter is operating on batteries, it is not possible to operate on the high range with the heater due to power requirements necessary to supply the heater current.

The sensor's "impedance" is measured by a 77 cycle 1 volt peak to peak square wave. To obtain this, the instrument contains

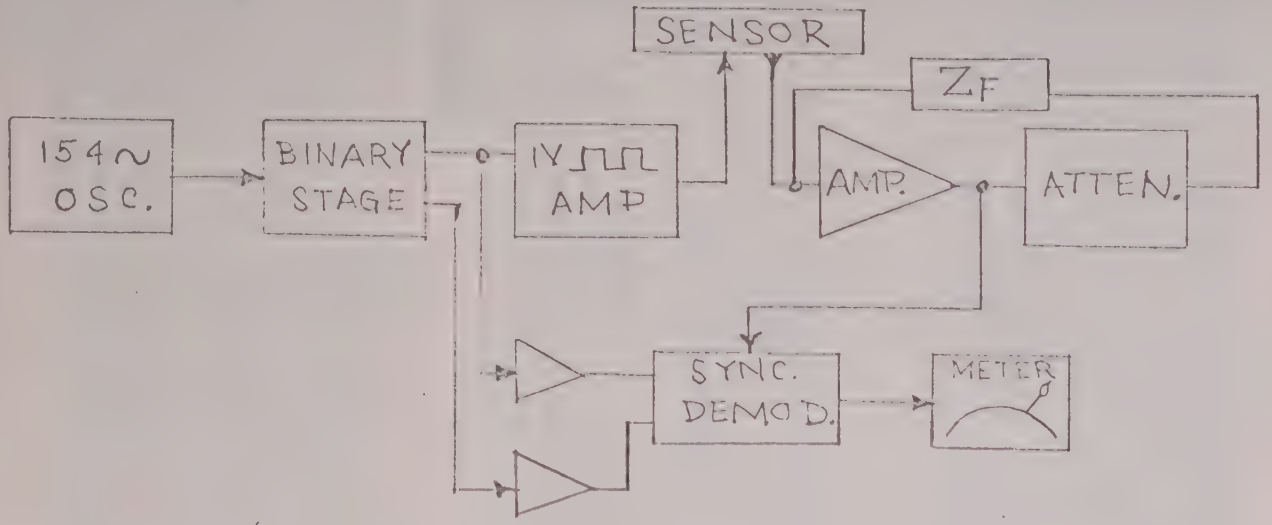


Figure 1

Humidity Gauge Block Diagram

SCALE:	APPROVED BY	DRAWN BY
DATE: 5/18/66		G.F.B.

PANAMETRICS
~~221 CRESCENT STREET~~
WALTHAM, MASS. 02154

DRAWING NUMBER A-2249

DIETZGEN NO. 196MF ADEPROOF "MASTER FORM"

a precision 154 cycle unijunction transistor relaxation oscillator whose output is divided by two by a Binary Stage. One output of the Binary Stage drives a clamped amplifier whose output is the precise 1V square wave.

The current through the sensor when excited by this 1V square wave is amplified by the AC coupled operational amplifier. The feedback path of the amplifier has a resistor/capacitor network whose phase angle is 45° which approximates the phase angle of the sensor over the major portion of its range. The gain of the amplifier is controlled by a RANGE switch which selects the proper tap of the precision attenuator. The amplifier's output is AC coupled to a 1:1:1 transformer which is part of the synchronous demodulator. The synchronous demodulator is driven through a biasing amplifier from the Binary Stage.

The output of the demodulator is attenuated and filtered to supply the current for the meter and the 100 millivolt full scale Recorder output. Resistor and capacitor networks to represent a 45K impedance for calibration is supplied internally so that the meter can be adjusted to full scale by the rear panel Calibrating potentiometer.

The five sensor inputs are manually selected via the SELECT front panel switch. The Range switch selects the proper amplifier attenuator, the calibrating network, and allows the sensor heater power to be supplied on the Hi range only.

154 Cycle Oscillator

The unijunction transistor relaxation oscillator operates at 154 $\pm$ 2 cycles. The power for this oscillator is a 9 V zener supply regulated to maintain good frequency stability versus power input variations. The frequency of the oscillator is a function of the RC network (R21-C8) and the firing potential of the unijunction Q3. Stable components have been chosen in the form of a 1% metal film resistor and a mylar capacitor to minimize drift with temperature. Due to the variations in the firing potential of the unijunction, the RC network must be trimmed by R22 whose value is selected in Final Test. If Q3 is replaced, the oscillator must be retimed and R22 changed.

Binary Stage

The pulse output of the oscillator is coupled via C9 to the Binary Stage which is a Signetics integrated circuit Flip Flop. The power for the circuit is derived from a 5 V zener regulated supply (R39 and CR3).

1 Volt Square Wave Source

The 1 volt square wave source is a clamped amplifier. The power for this amplifier is derived from the 9 V regulated source used also by the oscillator. One output of the Flip Flop is used to drive this two stage amplifier. The second stage of this amplifier has precision metal film resistors in the collector circuit with a 9:1 ratio, thus, providing a 1V output. Due to the variations in the 9 V zener tolerance, the 9:1 divider requires a trim resistor, R30, to ensure that the output is exactly 1 V peak to peak.

Synchronous Demodulator and Driver

The synchronous demodulator is composed of the transformer T1, and the chopper transistors Q1 and Q2. The transistors are alternately turned on thus grounding the individual legs of the transformer. Thus, the center tap of the transformer will always be positive with respect to ground and ungrounded leg will be open circuited. The drivers for the chopper transistors initially hold the bases of the choppers at about -8 V (well into cut-off) to prevent the transistor turning on during transition or due to transients. The drivers allow the bases of the chopper transistors to go slightly positive when they are turned off by the signals from the Binary Stage.

Metering Circuit

The output of the demodulator is attenuated and filtered by R17, R18, and C7 to drive the meter, M1. The meter protection in the form of back to back diodes, CR1 and CR2, prevent meter overloads in excess of five times full scale current. The recorder output is derived from the attenuator and filter, R14, R15, R16, and C6. Maximum full scale voltage is 100 millivolts across the low impedance of 200 ohms.

Amplifier

The 1 volt square wave source is fed to the selected sensor via the SELECT switch, S1b. The return from the sensor is fed via the SELECT switch section, S1a, to the RANGE switch section, S2b, and therein coupled to the amplifier input. A 300 picofarad capacitor is in parallel with the sensor at all times. This capacitor has been added to compensate for the phase angle changes in the extreme high impedance sensor range only. Its impedance is negligible at the lower scale ranges.

The signal from the sensor is AC coupled via R2 and C3 to the amplifier input. The feedback network composed of R3, R4, and C4 is connected to the range switch, S2a, which selects the proper tap of the attenuator network. R4 is a temperature compensating resistor used to vary the gain of the amplifier with temperature change, thus compensating for variations due to the copper resistive component changes of the system, namely, the meter and the transformer, T1.

SERVICING PROCEDURE

No routine maintenance is normally required on the Model 1000. If the instrument should malfunction, the trouble should be isolated to either the sensor element and associated cable or the readout electronics. Substitution of a sensor element known to be good can be used for this isolation process.

In most cases a quick test can be performed to determine whether the malfunction is internal to the readout electronics as follows:

With all sensor cables disconnected from the unit, plug the line cord into a power source of appropriate voltage and rotate the range switch to the "CAL" position. For a properly functioning unit it will be possible to adjust the meter to read full scale with the "CAL" pot adjustment on the rear of the unit. The pot position which produces full scale deflection should be reasonably close to its mid position. After the meter has been adjusted to read full scale, rotate the range switch to the "1" position. In this position the meter should read approximately 0.06. If these conditions are met, it is probably the case that the sensor element and/or connecting cable are defective.

If the readout electronics unit is found to be defective, any qualified electronic technician should be able to locate the trouble with the aid of the schematic diagram, theory of operation, and Figures 1 through 8 showing the proper waveforms at key test points.

It is suggested that, for troubleshooting purposes, all sensor cables be disconnected from the unit and the range switch put in the "CAL" position.

Waveforms should be checked at the following test points to isolate the defective portion of the circuitry:

1. Observe the waveform at the junction C_8, C_9, and R_{23}. If the 154 Hz oscillator is working properly the waveform should be as shown in Figures 1 and 2. If Q3 IS DEFECTIVE AND MUST BE REPLACED, IT IS NECESSARY TO RESELECT R_{22} TO BRING THE OSCILLATOR FREQUENCY TO 154 Hz $\pm$ 2 Hz.

2. Check for proper operation of the flip-flop by observing the waveform on pin 2 of A2. Figure 3 shows the proper waveform at this point.

3. Check for proper operation of the 1 volt square wave source by observing the waveform at TP11. Figure 4 shows the proper waveform at this point.

IF CR4 IS DEFECTIVE AND MUST BE REPLACED, IT IS NECESSARY TO RESELECT R_{30} TO BRING THE PEAK TO PEAK AMPLITUDE OF THE SQUARE WAVE AT TP11 TO 1 VOLT.

4. Check for proper operation of the amplifier and feedback network by observing the waveform at TP16. Figure 7 shows the proper waveform at this point.

5. Check for proper operation of the demodulator by observing the DC voltage at TP9. Proper voltage at this point should be approximately +100 mv DC.

The above steps have been presented as a guide. In some cases it may be possible to eliminate some of the steps as a result of the observed symptoms of a malfunctioning unit.

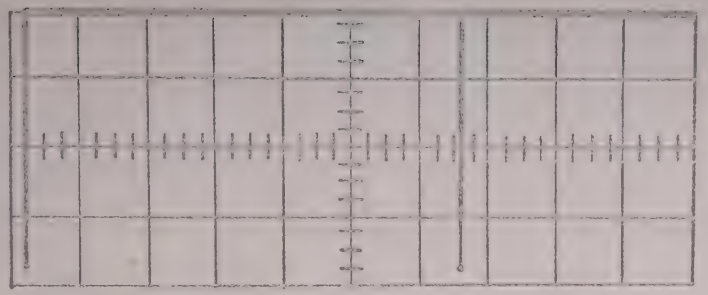


Figure 1.

Horizontal 1 msec/cm
Vertical 1 v/cm

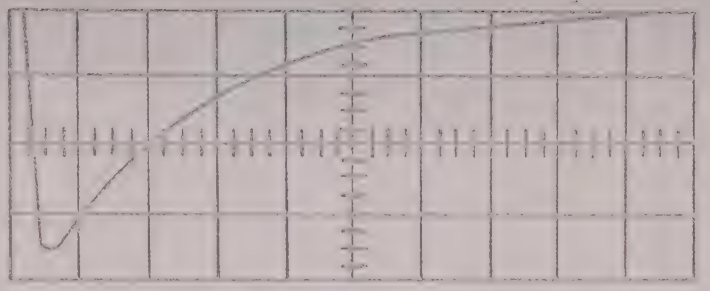


Figure 2.

Horizontal 5μsec/cm
Vertical 1 v/cm

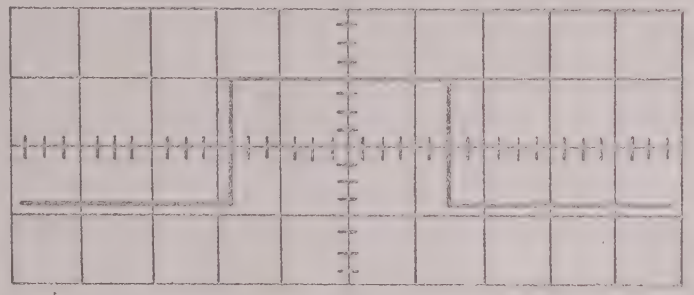


Figure 3.

Horizontal 2msec/cm
Vertical 2v/cm

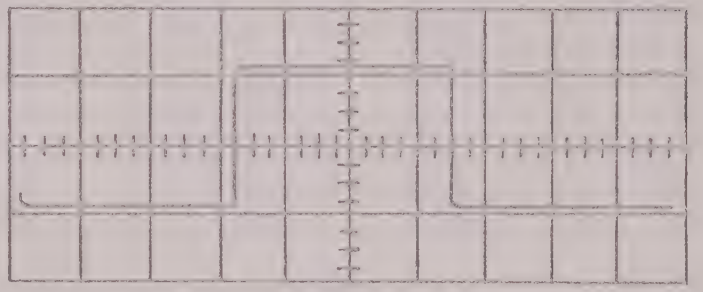


Figure 4.

Horizontal 2msec/cm
Vertical 0.5v/cm

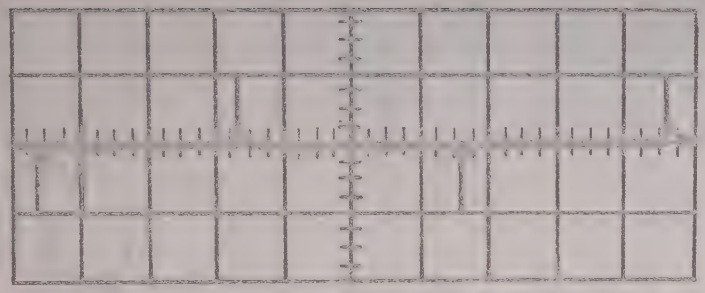


Figure 5.

Horizontal 2msec/cm
Vertical 0.5v/cm

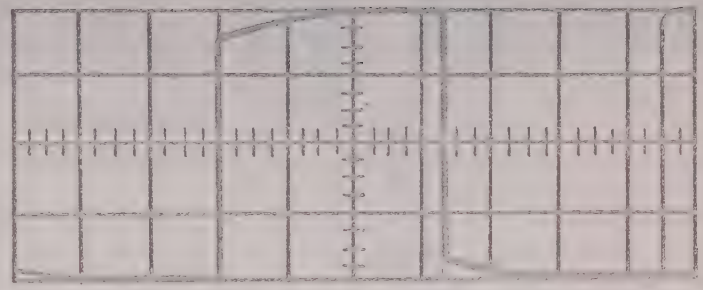


Figure 6.

Horizontal 2msec/cm
Vertical 0.5v/cm

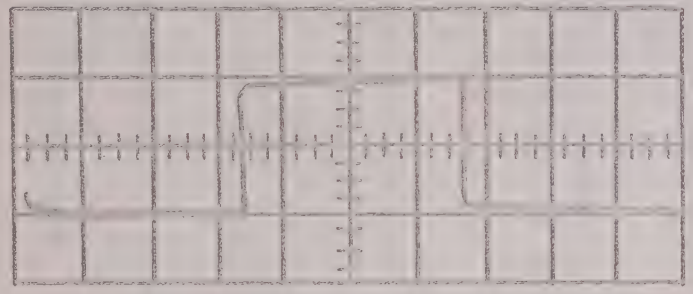


Figure 7.

Horizontal 2msec/cm
Vertical 5v/cm

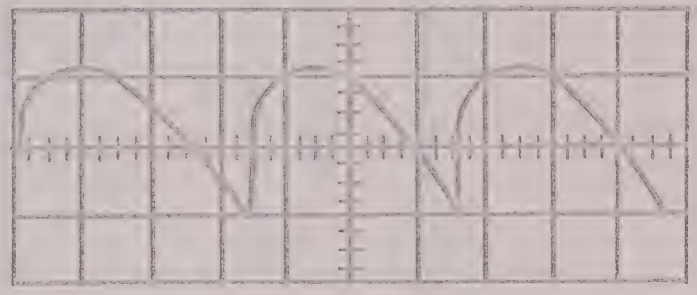


Figure 8.

Horizontal 2msec/cm
Vertical 0.2v/cm

SPECIFICATIONS

Electrical

Ranges: There are four dewpoint ranges selected by front panel switch S2.

Range	Dew/Frost Point Region
High	For use with special high humidity probe only
10	> + 10°C
3	+ 10°C to - 40°C
1	- 40°C to -110°C
	approximate, depending on sensor calibration

Accuracy: ± 1% full scale on all four ranges.
Sensitivity: Better than .1% on all four ranges.
Ambient Temperature Range: -10°C to + 55°C for electronic circuitry.
Warmup Time: Less than 5 minutes.
Calibration: A calibration curve is supplied with each element.
Shock and Vibration: Standard shipping specifications.
Input: Five probe input jacks selected by front panel switch S1.
Recorder Output: 0 to 100 millivolts across a 200 ohm impedance.
Power Supply: AC - Line voltage 105-125 volts/210-250 volts @ 48 to 63 cps.
Power - Less than 6 watts
DC - Nickel-Cadmium battery pack

Note: Available with AC power only or both AC and battery operation (see List of Accessories).

Accessories: 1. Probes (specify either type)

(a) Probe adapter with 3/4 - 14 NPT pipe bushing (Model P2)

(b) Probe adapter for wall mounting with "O" Ring flange (Model P1)

2. Internally mounted battery pack and recharger

Mechanical

Size: 12 3/8" W x 10 1/8" D x 6 1/2" H.
Weight: 11 1/2 pounds net.
Construction: Cast aluminum cabinet housing with formed metal rear cover plate. Unit is designed for either bench or wall mounting.
Finish: Textured dark gray cabinet trimmed with blue, light gray, and brushed aluminum satin finish.

WARRANTY

Panametrics warrants each instrument manufactured by them to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing or calibrating any instrument returned to the factory for that purpose and to replace any defective parts therof. Fuses and batteries are specifically excluded from any liability. This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when, upon our examination it is disclosed to our satisfaction to be defective. If the damage has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

If any fault develops, the following steps should be taken:

1. Notify us, giving full details of the difficulty, and include the model and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid, to the factory or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins provided the instrument is not covered by the warranty.

Shipping Instructions

All shipments of Panametrics instruments should be made via express truck or Railway Express. The instrument should be packed

in original shipping carton or packed in a strong exterior container and surrounded by two or three inches of excelsior or similar shock absorbing material.

Claim for Damage in Shipment

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report should be forwarded to us. We will then advise you of the disposition to be made of the equipment and arrange for repair or replacement. Include model number and serial number when referring to this instrument for any reason.

APPENDIX

PARTS LIST

Circuit Symbol	Description	Manufacturer
M1	Meter, 500 μa. with special scale (A141-012)	Triplett Electric
	Control Knob	Control Knobs, Inc.
S1	Switch, PA-1013	Centralab
S2	Switch (Dwg. No. B141-010)	Centralab
S3	Switch, SS-34	Stackpole
T1	Transformer, A52-J	Triad
T2	Transformer, (A141-011), T-9032	Tenco Electronics
	Printed Circuit Card (D141-007)	Astro Circuits, Inc.
A1	Operational Amplifier, Model 106	Analog Devices
A2	Integrated Circuit, GEC-C7551K	Signetics
C1	Capacitor, 300 μμfd, ± 5%, dipped mica, DM-15-301J ± 5%	Elmenco
C2	Capacitor, .0325 μfd, 100V, 1% mylar, 1MD1 - .0325 - 1%	Elmenco
C3	Capacitor, 33 μfd, ± 20%, 10V, solid tantalum, 150D-336x0010 - B2	Sprague
C4	Capacitor, .015 μfd, 100V, 1% mylar, 1MD1-153-1%	Elmenco
C5a	Capacitor, 68 μfd, ± 20%, 15V solid tantalum, 150D-686 x 0015 - B2	Sprague
C5b	Capacitor, 68 μfd, ± 20%, 15V solid tantalum, 150D-686 x 0015 - B2	Sprague
C6	Capacitor, 22 μfd, ± 20%, 15V Solid tantalum, 150D-226 x 0015 - B2	Sprague

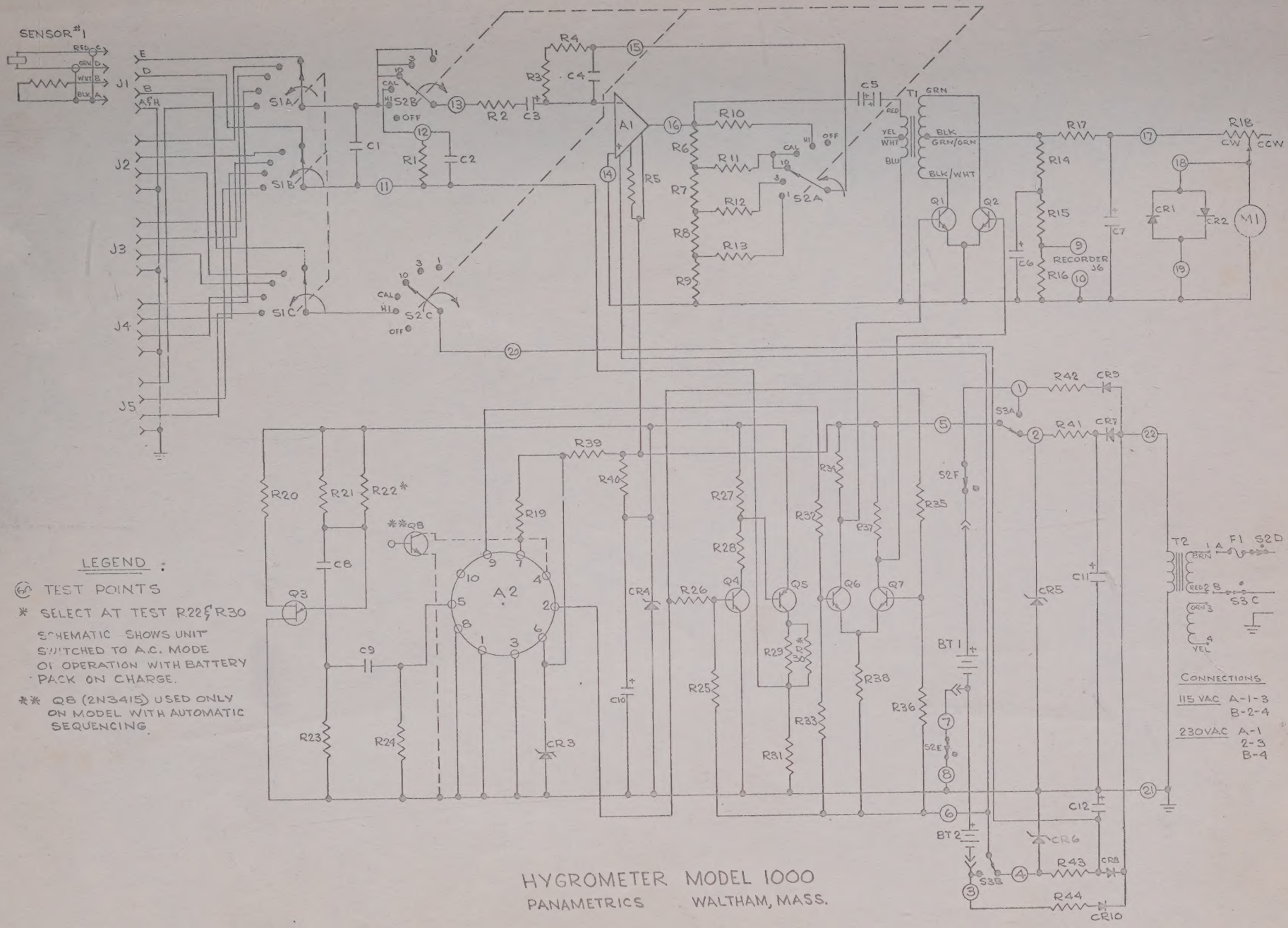
Circuit Symbol	Description	Manufacturer
C7	Capacitor, 50 μfd, 3V, electrolytic TE-1058	Sprague
C8	Capacitor, 0.1 μfd, dipped mylar 1-DP-2-104	Elmenco
C9	Capacitor, .01 μfd, disc ceramic CK-103	Centralab
C10	Capacitor, 5 μfd, 12V, electrolytic TE-1127	Sprague
C11	Capacitor, 500 μfd, 50V, electrolytic, BR-500-50	Cornell-Dubilier
C12	Capacitor, 500 μfd, 50V, electrolytic, BR-500-50	Cornell-Dubilier
CR1	Rectifier diode, 1N4003	Motorola
CR2	Rectifier diode, 1N4003	Motorola
CR3	Zener diode, 1N751A	Motorola
CR4	Zener diode, 1N936	Motorola
CR5	Zener diode, 1N3024B	Motorola
CR6	Zener diode, 1N3024B	Motorola
CR7	Rectifier diode, 1N4003	Motorola
CR8	Rectifier diode, 1N4003	Motorola
CR9	Rectifier diode, 1N4003	Motorola
CR10	Rectifier diode, 1N4003	Motorola
Q1	Transistor, 2N3415	General Electric
Q2	Transistor, 2N3415	General Electric
Q3	Transistor, 2N2840 (unijunction)	General Electric
Q4	Transistor, 2N3415	General Electric
Q5	Transistor, 2N3638	Fairchild
Q6	Transistor, 2N3415	General Electric
Q7	Transistor, 2N3415	General Electric

Circuit Symbol	Description	Manufacturer
R1	Resistor, 63.7K ohm, 0.1W, 1/4%, 20 ppm/°C	Daven Electric/ Precision Resistor Co.
R2	Resistor, 1.0K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R3	Resistor, 135.3K ohm, 0.1W, 1/4%, 20 ppm/°C	Daven Electric/ Precision Resistor Co.
R4	Resistor, 2.2K ohm, 1/4W, ± 5% T. C. 0.6%/°C	Daven Electric/ Precision Resistor Co.
R5	Resistor, 15K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R6	Resistor, 7777 ohm, 0.1W, 1/4% 20 ppm/°C	Daven Electric/ Precision Resistor Co.
R7	Resistor, 1555 ohm, 0.1W, 1/4%, 20 ppm/°C	Daven Electric/ Precision Resistor Co.
R8	Resistor, 444 ohm, 0.1W, 1/4%, 20 ppm/°C	Daven Electric/ Precision Resistor Co.
R9	Resistor, 222 ohm, 0.1W, 1/4%, 20 ppm/°C	Daven Electric/ Precision Resistor Co.
R10	Resistor, 2490 ohm, 1%, RN60D-2491F	Mepco
R11	Resistor, 787 ohm, 1%, RN60D-7870F	Mepco
R12	Resistor, 1870 ohm, 1%, RN60D-1817F	Mepco
R13	Resistor, 2260 ohm, 1%, RN60D-2261F	Mepco
R14	Resistor, 4990 ohm, 1%, RN60C-4991F	Mepco
R15	Resistor, 4990 ohm, 1%, RN60C-4991F	Mepco
R16	Resistor, 200 ohm, 1%, RN60C-2000F	Mepco

Circuit Symbol	Description	Manufacturer
R17	Resistor, 8450 ohm, 1%, RN60C-8451F	Mepco
R18	Potentiometer, 1000 ohm, 1-1/2W, wire wound, 49M9-1000	Clarostat
R19	Resistor, 10K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R20	Resistor, 270 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R21	Resistor, 75K ohm, ± 1%, RN60D-7502F	Mepco
R22	Resistor, trimmer RN60D (value chosen in final test)	Mepco
R23	Resistor, 100 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R24	Resistor, 1.0 meg ohm, 1/4W, ± 5% carbon	Allen-Bradley
R25	Resistor, 100K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R26	Resistor, 2000 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R27	Resistor, 10K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R28	Resistor, 10K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R29	Resistor, 4020 ohm, ± 1% RN60C-4021F	Mepco
R30	Resistor, trimmer RN60D (value to be chosen at final test)	Mepco
R31	Resistor, 499 ohm, ± 1% RN60C-4990F	Mepco
R32	Resistor, 3900 ohm, 1/4W, ± 5% carbon	Allen-Bradley

Circuit Symbol	Description	Manufacturer
R33	Resistor, 3900 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R34	Resistor, 15K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R35	Resistor, 3900 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R36	Resistor, 3900 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R37	Resistor, 15K ohm, 1/4W, ± 5% carbon	Allen-Bradley
R38	Resistor, 4700 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R39	Resistor, 240 ohm, 1/4W, ± 5% carbon	Allen-Bradley
R40	Resistor, 665 ohm, ± 1% RN60D-6650F	Mepco
R41	Resistor, 200 ohm, 3W ± 10% wire wound	Tru-ohm
R42	Resistor, 450 ohm, 3W, ± 10% wire wound	Tru-ohm
R43	Resistor, 1000 ohm, 1/4W, ± 5%, carbon	Allen-Bradley
R44	Resistor, 450 ohm, 3W, ± 10% wire wound	Tru-ohm
F1	Fuse, 1 amp, 3AG-1	Littlefuse
	Fuseholder #342014	Littlefuse
J1	Sensor input connector, #126-218	Amphenol
J2	Sensor input connector, #126-218	Amphenol
J3	Sensor input connector, #126-218	Amphenol
J4	Sensor input connector, #126-218	Amphenol
J5	Sensor input connector, #126-218	Amphenol

Circuit Symbol	Description	Manufacturer
J7	Recorder connector, #11	Switchcraft
J8	Battery input connector recpt., #57JD3M	Switchcraft
	Power Cord, 6', 3 conductor, #18 wire with molded plug #17237B	Belden
	Strain relief, SR-6 P-1	Heyco



HYGROMETER MODEL 1000

PANAMETRICS WALTHAM, MASS.

MP MASTER
MA30184